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REPORT

OF THE

COMMITTEE

APPOINTED BY THE

BOARD OF PUBLIC EDUCATION

TO INQUIRE INTO THE

SANITARY CONDITION OF THE SCHOOLS

OF THE

First School District of Pennsylvania,

City of Philadelphia. Board of public education

CONTAINING

ANALYSES OF THE AIR OF SCHOOL ROOMS, REPORTS OF PHYSICIANS, TABULAR STATEMENTS, AND DETAILS OF THE SANITARY CONDITION, ETC., ETC., OF TEACHERS AND PUPILS.

PHILADELPHIA:
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REPORT.

Philadelphia, July 13, 1875.

To the Board of Public Education,
First School District of Pennsylvania.

GENTLEMEN: The Committee to which was referred the communication of the Social Science Association of Philadelphia, in regard to the hygienic condition of the Public Schools of this city, respectfully report, that it has given the subject matter of the communication the fullest consideration, and used all the appliances at its command, to secure the information desired by the society named.

The work of collecting the facts embraced in the accompanying papers, was not by any means an easy one, as will be demonstrated by a reference to those papers, yet with all its difficulties it was cheerfully undertaken, alike by those who contributed to their preparation, either by presenting the facts, the making the chemical investigations, and the summarizing and reporting upon them.

In their work the Committee received much valuable assistance from Mr. R. Thomson, of the Boys' Central High School, Dr. Pemberton Dudley, Dr. J. Gilbert Young, and other scientific and medical gentlemen, to whom it here makes its acknowledgments, and expresses its thanks for the good services rendered by them.

From Dr. B. L. Ray, who carefully examined all the reports of the scientific gentlemen, the Committee received very important aid, and are under great obligations to him for the very clear, concise and satisfactory summary which he prepared—which summary is herewith presented to the Board.

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Whilst many of the reports received are not as full as desired, it is yet a satisfaction that every school in the district (with two exceptions) has been heard from, and the only source of regret with your Committee arises from their inability to secure a thorough medical examination in every section.

The Committee urgently request each Member of the Board to carefully examine the papers presented, that they may become not only acquainted with the facts which are connected with their section, but with those of all the sections, to the end that they may, when the time shall arrive for action by the Board, upon the many subjects treated of in the report, be able to act promptly and effectively in bringing about the much needed improvements in the hygiene of our Public Schools.

An examination of the papers will make it apparent, that in a large number of the schools reform is much needed in the matter of the position of the pupils' desks and the black-boards, as regard the direction from which the light enters the class-rooms. In the class-rooms where the positions of the desks are faulty, because of the light falling directly upon the face of the pupil, when sitting at the desk, they should as far as possible have their positions so changed that the light may be received at the side or from behind the pupil, and the black-boards be so arranged as to be in harmony with the light received from such directions. There cannot, the Committee feel free to say, be any excuse, much less any justification for such architectural arrangement of school-houses which may hereafter be built, as will not secure the arrangement of the desks and black-boards to be in such position with the windows of the class-rooms that the reception of the light upon them and the pupils will be either from the side or from behind the pupils when seated at the desks, or when working on the black-board.

As regards the matter of physical exercise, the Committee feel called upon to remark, that while it may not be possible from the peculiar construction of some of the school-houses to have space sufficient and the other necessary conditions to permit of gymnastic exercises being engaged in by the pupils,

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with benefit in the class-rooms, yet the importance of physical exercise, as a means, if of nothing more, of withdrawing the brain from its toil, and of thus securing mental relaxation, should not be overlooked, and hence that in some form such exercise should not only be indulged in, but commanded at set periods every day. If from the arrangement of the school-rooms the exercises cannot be practiced in the school-building, they may, nevertheless, be engaged in outside of the class-rooms, in the yards attached to most of the school-houses.—The Committee fear that the law of the Board which requires that the pupils shall have a recess each morning of thirty minutes, is not universally complied with by the teachers, and that in some instances it is advised the morning session is continued without interruption for two and a-half hours, when the pupils are dismissed, the thirty minutes being added to the period intervening between the closing of the morning and the opening of the afternoon sessions, thus making the morning session from 9 o'clock to 11.30 o'clock, instead of, as ordered by the Board, from 9 A. M. to 12 M., with a recess of one-half hour during that period. Whilst this arrangement, on the part of those teachers who direct it, virtually gives to the pupils the full time for tuition directed by the Board to be given to them, the sanitary and hygienic purposes of the morning recess, namely, the taking from the brain the tension to which it has been for an hour and a-half submitted, and the exposing of the children to the healthful influence of a better light and purer air than that of the school-room, and the mental and physical invigoration which results from that abandon and giving up to free and unrestrained natural and joyous exercise of the physical and mental systems, as may be seen in any school-yard during recess, is cruelly denied the children. In every instance where the recess required by the Board is withheld from the children, there is a gross wrong done to them, the effects of which your Committee fear, in too many instances, present themselves in impaired health, enfeebled brain power, and defective nerve force—the outcrop-

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pings of which are too often seen in that sad condition of early womanhood and early manhood, as qualified by the terms—"broken down health," and "shattered constitutions." The wrong referred to must not be tolerated. It must be arrested, and the Board should see to it, that by the due infliction of proper penalties upon the teachers who deny to the pupils their rights in the matter of the healthful benefits incident to the thirty minutes morning recess, shall be made to realize the importance to the pupils, of the mental and physical relaxation and invigoration which result from their withdrawal of thirty minutes from their labors in the school-room, and their devotion of the recess to exercise and pastime in the open air.

In reference to the school furniture, the facts collected justify the conclusion that the pupil's desks, which have for the past few years been furnished, are, as regards their height for the different grades of schools, their form, and the construction and shape of the seats, such as largely meet the requirements of the pupils for comfort and health.

The subject of the ventilation and warming of the school-houses largely engaged the attention of the Committee. Upon this branch of their investigation many very interesting and important facts have been collected, which must, if properly regarded, aid very positively in securing for the class-rooms their better heating and pure effective ventilation. The Committee are not ignorant of the fact, that the matter of heating and ventilating school-rooms, and indeed all rooms in which large numbers of persons remain for hours, is fraught with many difficulties, and that able minds have been, as they are now, engaged in endeavoring to solve the problem, of how to successfully warm and ventilate assembly rooms. In view of these difficulties, and with the belief that the Committee presents to the Board something practical in reference to the improvement of the ventilation of the school-rooms, the Committee invite special attention to the suggestions of one of the Committee, Dr. Nebinger, as embodied in his report of the hygienic condition of the class-rooms of the Second Section.

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The Committee not only invite the attention to these suggestions, but recommend that the suggestions be put into immediate practical operation.

A source of atmospheric contamination very generally complained of in the reports, is, the foul and disgusting emanation from privies connected with some of the school-houses. This source of atmospheric contamination is entirely within the power of the means of control, and should at the earliest possible period be remedied by the emptying of the wells, the free use of disinfectants, and the connecting of the privies by means of properly constructed wooden or terra-cotta ventilating tubes with the smoke flues of the school-houses, a means at once efficient, simple, and easy of application.

A very serious complaint comes from some of the sections in regard to the inadequacy of the heating apparatus. The Committee suggest that in every instance complained of, that it be duly inquired into, and if found well based, that the needful remedy shall be applied.

Advanced sheets of the tabulated matter of this report, and the reports of the scientific gentlemen upon the atmosphere and ventilation of the school-rooms, were furnished to Dr. D. F. Lincoln, of Boston, who made use of them in his very interesting report presented to the American Social Science Association at its meeting held at Detroit, Michigan, May 11, 1875. In referring to these reports Dr. Lincoln said, in substance, that the facts embodied in them were the first of the kind that had been collected and tabulated by any Educational Board. Thus it will be seen that this Board has been, to a certain extent, a Pioneer in a specialty of hygiene, as connected with Public Schools. Since the presentation to the American Social Science Association, of the matter contained in the accompanying tabulated reports, a series of questions similar to those of our reports have been prepared by the school authorities of St. Louis, and circulated among the teachers of the schools of that City, for the purpose of obtaining information in regard to the hygienic condition of its Public Schools.

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The abstracts of the several reports received by your Committee do not show as satisfactory a condition of our school buildings as could be wished, and yet we feel that the very plain and pointed statements of defects as given by teachers and physicians, will induce our respective committees and the various Sectional Boards to take immediate steps to remove the difficulties complained of, and to this end your Committee would respectfully ask that this report, with the accompanying documents, be printed in pamphlet form for general distribution.

The Board will find herewith copies of the blanks prepared by your Committee and abstract of the answers received, classified under the heading of "Grammar," "Consolidated," "Secondary," and "Primary" Schools.

We have the honor to be,

Very respectfully, yours,

LOUIS WAGNER, *Ch'n*,
D. STEINMETZ,
A. NEBINGER.
} *Committee.*

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DETERMINATIONS OF CARBONIC ACID AND OF WATER IN AIR,

(Schools in Second Section,)

By E. Thomson, High School Laboratory.

The following analyses were undertaken with a view to finding the amount of carbonic acid which may be expected to exist in the atmosphere of an ordinary school-room, and to discover, if possible, conditions favorable and unfavorable to good ventilation.

In the first place, however, it becomes necessary to decide what proportions of constituents may be regarded as pure or normal air, such as may be taken as a standard of comparison. Many investigators and prominent among them, Dr. R. Angus Smith, recognize the following proportions of gases as expressing very nearly the composition of pure or normal air, watery vapor excluded.

	Per cent. by measure.
Oxygen, - - - -	20.96
Nitrogen, - - - -	79.00
Carbonic Acid, - - -	.03 to .04

The amount of carbonic acid varies slightly above and below the amount given.

The two following analyses of external air, agree, in general, with the proportions given. The amount of water is also given.

The observations are calculated for a standard of 60° F.

In all the analyses here given, the *volume* of carbonic acid found, is compared with 10,000 *volumes* of air. The water is given in parts by *weight* compared with 10,000 parts by *weight* of air.

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No. 1. Analysis of Pure External Air.

The sample was taken February 27, at a temperature below the freezing point. There was high wind at the time, and the day was cloudy.

	Volumes in 10,000	Parts by Weight.
Carbonic Acid, - -	2.88	4.08 in 10,000
Water, - - - - -		37.68 in 10,000

No. 2. Analysis of Pure External Air.

This sample was taken March 13th; temperature 55° F.; weather, rainy and damp, with very little wind:

	Volumes in 10,000	Parts by weight.
Carbonic Acid, - - -	3.205	4.54 in 10,000
Water, - - - - -		75.14 in 10,000

The results obtained by Dr. R. A. Smith, show that, in general, the more wind, the less the carbonic acid, and that, during a calm, it rises in quantity. This fact is, doubtless, due to the wind preventing the formation of local atmospheres containing higher proportions of carbonic acid.

His results also show that in cities, the amount is greater than in the rural districts, unless very high winds prevail.

Besides the gases already referred to, a trace of ammonia and a small proportion of carbides of hydrogen, are generally present in air.

Pure air is contaminated by the operation of many causes. The sources of impurity may be briefly tabulated as follows:

Respiration, introducing

Carbonic acid, water, with organic impurities, ammonia and similar substances.

Combustion, as of wood, gas, or coal:

Carbonic acid, water, hydrocarbon vapors, sulphurous acid, acetic acid, soot, &c.

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Fermentation, animal and vegetable decomposition:

Carbonic acid, ammonia, sulphide of hydrogen-carbides of hydrogen, &c., e. g. sewer gases.

General wear and tear, and miscellaneous sources of impurity:

Animal excreta, volatile oils, &c., fibres from clothing, emanations during disease, organic germs, &c.

In school-rooms, all of these sources exist to a greater or less extent. The impurities thrown off in respiration, are, doubtless, in many cases, added to by leaky flues in heaters and stoves, gases from sewers, and the like, and impurity arising from neglect of cleanliness of the pupils.

In all the sources of contamination mentioned, carbonic acid is produced, and its quantity may, with few exceptions, be taken as an index of the presence or absence of other and more harmful substances.

Pure carbonic acid, mixed with air, exerts but little truly poisonous action, but when *accompanied, as it usually is, by quantities of organic putrescible substances, for continued respiration, it is most injurious.*

The following analyses give the proportions of carbonic acid and water as found in samples of air taken from schools in the Second Section. In all cases the schools were in full session.

No. 3. Wharton School-House.

Boys' Secondary—Second Division; about 30 pupils present; one window open about 2 feet; weather, damp; outside temperature a few degrees above the freezing point.

30 pupils—155 cubic feet of air to each pupil.

The results of analysis are:

	Volumes in 10,000.
Carbonic acid,	11.68.
Water,	76.58 parts, by weight, in 10,000.

The carbonic acid is about three times that of normal air. The water found agrees with the damp condition of the air.

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No. 4. Wharton School-House.

30 pupils—160 cubic feet of air to each pupil.

Boys' Primary—First Division; about 30 pupils; one window open 8 or 10 inches; large transom over the door, wide open; fair weather, temperature outside 47°.

Volumes in 10,000.

Carbonic acid, 5.93.

Water, 70.09 parts, by weight, in 10,000.

A strong draft of cold air from the transom was noticed while taking the sample used in this analysis, which fact fully accounts for the low proportion of carbonic acid found.

No. 5. Wharton School-House.

41 pupils—152 cubic feet of air to each pupil.

Girls' Secondary—Fourth Division; no windows open; the transom partly so; weather, very bad, high wind and shower of sleet.

Volumes in 10,000.

Carbonic acid, 15.33.

Water 60.61 parts, by weight, in 10,000.

The amount of carbonic acid is considerable and arose from the necessity for closing the windows on account of the storm.

No. 6. Geo. W. Nebinger School-House.

For each of the 190 pupils or four divisions crowded into two class rooms, for a special purpose, there were but 66 cubic feet of air. At ordinary times there are about 140 cubic feet of air for each pupil.

Two rooms were being used connectedly, with over 190 pupils of the boys' primary, two windows open each about 10 inches, two transoms partly open; weather, bright and clear.

Volumes in 10,000.

Carbonic acid, 21.34.

Water, 57.73 parts, by weight, in 10,000.

For the purpose of receiving instruction in music, four divisions were crowded into the space ordinarily occupied by two. The proportion of carbonic acid and organic impurities is therefore high.

It is proper to state that such crowded condition was for a half hour only.

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No. 7. GEO. W. NEBINGER SCHOOL-HOUSE.

Girls' Grammar—Fourth Division; 40 pupils; two windows down, 4 inches each; weather, dull and cloudy; inside temperature about 72°.

40 pupils—158 cubic feet of air to each pupil.

Volumes in 10,000.

Carbonic acid, 16.26.

Water, 65.65 parts, by weight, in 10,000.

In this instance the amount of carbonic acid might have been less had the windows been opened to a greater extent; at the same time, the temperature being high would not have been inconveniently reduced by so doing.

No. 8. GEO. W. NEBINGER SCHOOL-HOUSE.

Boys' Grammar—First Division; 30 pupils; one window open to a small extent; weather very fair; inside temperature 66°.

41 pupils—155 cubic feet of air to each pupil.

Volumes in 10,000.

Carbonic acid, 12.68.

Water, 44.17 parts, by weight, in 10,000.

The amount of carbonic acid is moderate.

No. 9. WASHINGTON SCHOOL-HOUSE.

Boys' Secondary—Fourth Division; 54 pupils; one window partly open: weather comparatively warm and fair.

54 pupils—161 cubic feet of air to each pupil.

Volumes in 10,000.

Carbonic acid, 16.77.

Water, 40.21 parts, by weight, in 10,000.

No. 10. WASHINGTON SCHOOL-HOUSE.

Girls' Secondary—Fourth Division; 38 pupils; one window fully opened; weather very fair.

38 pupils—210 cubic feet of air to each pupil.

Volumes in 10,000.

Carbonic acid, 8.65.

Water, 45.61 parts, by weight, in 10,000.

The low amount of carbonic acid is traceable to the ventilation afforded by the open window.

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No. 11. Washington School-house.

58 pupils—140 cubic feet of air to each pupil.

Boys' Primary—4th Division; 58 pupils; three windows open 1½ feet; weather bright and clear.

Volumes in 10,000.

Carbonic acid, 10.16.

Water, 40.57 parts, by weight, in 10,000.

In this case, again, the proportion is low, and is evidently due to the number of windows open, thus affording rapid change of air.

The following analysis is of air taken from one of the rooms of the High School building when about 40 pupils were present.

No. 12. From High School.

One window wide open; weather extremely damp and rainy.

Volumes in 10,000.

Carbonic acid, 12.70.

Water, 103.12 parts, by weight, in 10,000.

The proportion of water is over one per cent., and shows at once the very moist condition of the atmosphere.

For purposes of comparison the breath, as exhaled from the lungs during respiration, was analysed, and found to contain—

Volumes in 10,000.

Carbonic acid, 378.48.

Water, 265.80 parts, by weight, in 10,000.

In other words the proportions are *by weight*, a little over 5 per cent. of carbonic acid and 2½ per cent. water.

The average proportion of carbonic acid from the ten analyses of air from school-rooms is 13.13 volumes in 10,000 of air, or about four times that found in normal or pure air.

There is no standard of purity which distinguishes good from bad air, since the one condition passes insensibly into the other, and a sample of air from confined situations is more or less pure or impure by comparison.

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It is safe to conclude, however, that if from 10 to 15 measures of carbonic acid exist in 10,000 of air, the latter cannot be regarded as of good quality, and must be unwholesome, but there can be no question that when the amount is 20 or more that positive injury must ensue to those remaining in such an atmosphere. Too much importance cannot be attached to the fact that although carbonic acid, *pure* and mixed with air, is comparatively harmless, yet, as in school-rooms and the like, it is always associated with the noxious products of organic changes, and that a large amount of these latter is almost always concomitant in the presence of a like amount of carbonic acid.

The foregoing analyses being made under varying conditions of temperature, wind, and moisture, afford no criterion as to the relative ventilation of the schools from which the samples were taken.

For example, the weather was much milder and more favorable when the samples used in Analyses 10 and 11 were obtained than was the case with several of the others. In some the temperature and state of weather was such as to preclude the use of open windows for ventilation.

From an attentive consideration of the conditions in each case, the following inferences are, perhaps, justifiable.

1. Under similar conditions the amount of carbonic acid and organic impurity will be greater in proportion to the age and size of the pupils.

Hence in the Primary Schools the purity, at least so far as carbonic acid is concerned, may exceed that of Secondary and Grammar Schools.

2. That undue crowding, especially in bad states of weather, as excessive cold, may, by the increase of impurities, produce conditions that are alike prejudicial to both teacher and pupil. In Analyses 6 and 9 the inference is clearly exemplified.

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3. No case was found in which the most moderate ventilation could have been secured without the use of open windows. Analyses Nos. 4, 10, and 11, which show the least amounts of carbonic acid, apply to cases in which open windows were doing the work of ventilation.

The amount of water in the air varies, of course, to a very considerable degree, but it is seldom less than one-fifth per cent., and never rises much above three per cent.

E. THOMSON.

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SUPPLEMENTARY TABLE. EXAMINATION OF AIR BY CHEMIST.

Schools in Second Section.

NAMES OF SCHOOLS.	Weather Outside as to Temperature	Weather Outside as to Dampness. "a."	Number of Pupils.	"3a" Cubic Feet of Air per Pupil.	"3b" C. O_2 Per Centage. (By volume.)	Water in the Air of Room. Parts by Weight in 10,000.	Windows open, Inches.	Transom.	REMARKS.
George M. Wharton Boys' Secondary, 2d Division	A little above freezing.	Damp	30	155	.1168	76.58	1, 24 inches.		
" " " Primary, 1st Division.	47°	Fair	30	160	.0593	70.09	1, 9 "	Large. Wide open	Strong draft from transom.
" " Girls' Secondary, 4th Division	About freezing.	Damp	41	152	.1533	60.61	Closed	Part open	Sleet and wind, compelled to close windows.
George W. Nebinger		Clear & bright	*190	*66	*.2134	57.73	2, 10 "	2, " "	Pupils crowded together for music lessons—only a half-hour.
" " Girls' Grammar, 4th Division		Cloudy	40	158	.1626	65.65	2, 4 "		Twice the ordinary density.
" " Boys' Grammar, 1st Division		Fair	30	155	.1268	44.17	1, slightly		
Washington Boys' Secondary, 4th Division	Warm	Fair	54	161	.1677	40.21	1, partly		
" Girls' Secondary, 4th Division		Fair	38	210	.0865	45.61	1, wide		
" Boys' Primary, 4th Division		Clear & bright	58	140	.1016	40.57	3, 18 inches.		
Boys' High School		Very Damp	40		.1270	103.12	1, wide		
			Averages ...	*150	.1315	60.43			*Exceptional circumstances, see remarks above.
February 27, Out door air No. 1	Below freezing.	Cloudy & windy			.0288	37.68			
March 13, Out door air No. 2	55°	Damp & calm			.03205	75.14			
air just exhaled from lungs, was found to contain					3.7848	265.80, or 2.658 p. ct.			

E. THOMSON.

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SECOND SECTION.

To the Sanitary Committee of the
Board of Public Education:

GENTLEMEN:—Desiring to have the atmosphere of a number of the class-rooms of the school-houses of the Second School Section analyzed with accuracy, to determine the percentage of carbonic acid in the air of each, we invited Mr. E. Thomson, A. B., Assistant to the Professor of Chemistry of the Boys' High School, to take charge of the investigation. Mr. Thomson, with great kindness and readiness, consented. He gave to the work of the analysis a large amount of time and labor, and prepared a report of his investigations which is herewith presented. The report is clear, comprehensive, and abounds in suggestive facts which cannot fail to interest those who give attention to the study of the laws of health.

It may be well here to remark that inasmuch as the class-rooms whose atmosphere Mr. Thomson examined, may be regarded as representing the average class-rooms of the school-houses of the First School District, that the results of the analysis of the atmosphere of these rooms therefore express about the condition of the atmosphere of all the class-rooms in the public school-houses of Philadelphia.

If, in the report of Mr. Thomson, one fact more than another is forcibly presented, it is that the means, apart from open windows, which are applied to ventilating our school-houses are inefficient.

In regard to the three rooms of the Wharton School-house, the air of which was analyzed, we have to record that although there are ventilating shafts and ventilators, so called, by which it has been supposed the ventilation of the rooms was secured, yet the only means as experience and science have demonstrated by which the ventilation of those apartments can be effected is by open windows.

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The other two school buildings, in which the atmosphere of three rooms of each was examined, and the results of the analyses reported by Mr. Thomson, are buildings which are known as new school-houses, one was built in 1868, the other in 1872, and are as complete and as well constructed as regards their ventilating appliances as any of the public school-houses of the city, yet Mr. Thomson's report exhibits that the ventilation of the rooms of these buildings is but little, if any, more satisfactory than the ventilation of the class-rooms of the Wharton building, where the powers of the ventilating apparatus may be expressed by a cipher.

Too much importance cannot be attached to the perfect ventilation of the school-rooms. In Philadelphia, during ten months of the year, about four and a half hours of each school day are spent in the school-rooms, by 90,000 children, ranging from six to seventeen years, and about 2,000 teachers. Who can possibly estimate to what extent the laws of health are violated by compelling these 92,000 persons to breathe day in and day out an atmosphere surcharged to the extent of five, six, or seven times the sum of carbonic acid that normal air contains, and then superadded to this a sum of organic impurities which may be expressed by the same numbers as indicate the excess of carbonic acid? Who can, in numbers, express the degree of violence done to health, the sum of human suffering engendered, and to what extent life may be shortened by the respiration of the unnecessarily impure atmosphere of school-rooms?

It must be borne in mind that an excess of carbonic acid is not the only pernicious matter which contaminates the air of school-rooms as a result of respiration, and of exhalation from the surface of the body, etc. There is organic or putrescible matter given off from the lungs at every respiration, which matter is held in solution in the watery vapor expired. This organic putrescible matter the best authorities declare is more injurious to health when inspired, than is the ordinary excess of carbonic acid which is present in defectively ventilated assembly rooms. Whilst there is not any means by which the

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organic putrescent matter can be quantitatively determined, yet it can, for all useful purposes, be approximately fixed. Thus the sum of putrescible matter in any school-room, for example, is expressed by the same figures as indicate the sum of the excess of carbonic acid. In other words, if the carbonic acid is five, six, or seven times in excess of the sum of that gas in normal air, then is the putrescible matter five, six, or seven times in excess of such matter in ordinary air. The watery vapor expired from the lungs, and which holds in solution the putrescible organic matter, is not under ordinary circumstances visible. It is rendered visible, however, by condensation, as is often seen on the glass of the windows and not unfrequently observed flowing down them in currents, where a large number of persons are assembled in a room when the external temperature is below the freezing point. Nearly the entire amount of the condensed vapor which is seen under such circumstances was once in the bodies, and with all its foul putrefactive matter was cast off or exhaled by those in the room, and in its aeriform condition, by being breathed or inspired, enters again the circulation of every one of the auditory, and much or little, corrupts and poisons their bodies. From these observations it will at once be seen, that there is a double necessity for efficient ventilating apparatus in all school-rooms and other rooms where the atmosphere is subjected to contamination from the presence of a large number of persons.

While we are disposed to regard with favor, the plan which has been applied of late years to the ventilation of our school-rooms, as embodying the practical and useful, yet we are confident, that it is in its operations, because of its defective application and details, inefficient. The imperfections referred to, in our estimation, although very positive, we think may be readily avoided in the application of the plan to the school-houses which may be hereafter constructed—and be largely remedied in many of our recently erected school-buildings.

The plan of ventilation now in vogue in our so called modern or new school-houses, is by openings into a shaft, or flue,

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through which an iron smoke or gas-pipe connected with the heater passes. This apparatus is defective in our opinion, first in the small size of the shaft, second in the size of the ventilating openings into the shaft, third in the localities of the openings. The shaft has not sufficient capacity to carry off with the required rapidity the contaminated air, even though the openings into it were of sufficient size, and in the best places to permit the air to pass with the required freedom from the room into the shaft, and through it into the external air. The ventilating registers are generally about 14 inches by 20 inches. The face of the register has many small openings in it, but it is however mainly made up of scroll or fret work, which embraces about two-thirds of the entire face, so that a ventilating register 14 by 20 inches gives an opening into the shaft, practically and absolutely, of about 5 by 7 inches only, through which small openings we unreasonably expect to have escape from a room containing from 40 to 50 children, the expired air, with sufficient rapidity to keep the atmosphere of the room at or near the normal condition. The mere presentation of these statements is of itself, we feel, sufficient to make clearly manifest the insufficiency of our plan of ventilation, yet, as we have already in substance remarked, we incline to the opinion that the fault is not in the principles involved in the plan, but in the details and the imperfections of their application. We would suggest that hereafter in all the school-houses which may be built under the supervision of the Board of Education, in which the plan of ventilation on which we have been commenting may be introduced, that the ventilating shafts shall be increased to thrice the capacity of those now in operation; that the openings into the shaft be not less absolutely than 16 inches by 24 inches, and that they be covered with iron doors which can be easily opened and closed partially or completely by teachers and janitors, and that these openings be near the ceilings. We have in our mind a form of frame and door with an arm, to which two cords could be attached, one for opening, the other for closing it, which would be far less costly than the

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ventilating registers now used, and which could be easily worked, and would present the smallest liability to get out of order.

If we would secure complete ventilation of the school-room, we must not contemplate its cost in the consumption of fuel. To warm properly and to ventilate efficiently our school-rooms, there are required large and well constructed heaters, whose hot-air chambers must communicate directly with the air outside of the school-house, through cold air trunks, and the ventilating shafts must be of large capacity, with openings into them of such dimensions as will permit the air to rapidly flow out of the room into the shaft and through it into the external air.

The factors of effective ventilation of our school-rooms in cold weather, are the introduction of a full supply of hot pure air, and the rapid escape without the sensible production of air currents, of the respired air. Until the heating and ventilating appliances of our school-rooms embrace these factors the class-rooms will present conditions prejudicial to health, vigor, and long life.

A. NEBINGER, M. D.

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FOURTEENTH SECTION.

No. 684 North Twelfth Street.

Philadelphia, March 15, 1875.

To the Board of Directors of the
Public Schools, Fourteenth Section.

Gentlemen:—Accompanying this you will receive duplicate reports of the results of the sanitary examination of the public school-buildings of your section. The time at my disposal, since my appointment about two weeks ago, was too limited to allow of such a general and thorough investigation, as I should have been glad to make; yet the results obtained are well worthy of your careful consideration. I here present certain facts in connection with our schools, which could not well be presented in the printed blanks.

The examinations for carbonic acid were made during the comparatively warm days of March 10th, 11th, 12th, and 15th. The windows of the rooms examined were more or less open in every case; yet a considerable quantity of carbonic acid ($C. O_2$) was detected in all of them. Wherever living beings are congregated there must, of course, be carbonic acid, but the fact that but one tenth per cent. or even less was found in one or two of the rooms proves that it is possible to maintain an equal degree of purity in all the others. On the other hand, the presence of .3 to .5 per cent. of carbonic acid in the school-rooms at Twelfth and Ely's avenue, with half-a-dozen of the windows lowered one foot from the top, is strikingly significant of what might be expected in colder weather, with the windows closed.

All the school-rooms in the ward appear to be sufficiently heated. An exception, however, is noted at the Monroe School. In this building, if the heat from the "side heaters" is turned on at the two upper floors the lower floor gets none at all. This could perhaps be easily remedied by means of dampers, so arranged as to prevent a portion of the warm air from rising to the upper rooms. As regards moisture, some of the teachers

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complain of dryness of the throat and weakness of voice during school hours. The absence of these symptoms during the warmer weather makes it probable that they are due not alone to the constant effort of speaking, but also in some degree to a deficiency of moisture in the air of the school-rooms.

The lighting seems to be sufficient in most instances, but would be still better, were the windows extended nearer to the ceilings. Such an arrangement would also add greatly to the comfort and healthfulness of the rooms during the hot weather. It is to be hoped that in school-buildings yet to be erected, this point may not be lost sight of. The *direction* of the light in relation to the position of the desks is faulty in very many cases; and it is difficult to suggest a remedy, inasmuch as any change in the position of the desks necessitates a change also in the location of the black-boards, maps, charts, &c., bringing them not unfrequently against the glass partitions, which would, of course, be objectionable.

The air space allowed each scholar is in some cases hardly sufficient, particularly in the primary schools, where the desks, being smaller, are crowded into a narrower space than in the higher schools. And while speaking of the desks, it may be well to state that in all the primary schools we find a few scholars of larger growth, whom the *primary* desks are too small and contracted to allow them to sit with comfort. Could not a few desks of a larger pattern be introduced into the primary schools, for the special use of the older pupils?

The outlets or ventilators are, in nearly all cases, much too small, and too few in number, and improperly located. The warm air, after leaving the register, should make a *complete* circuit of the room before passing out at the ventilator. This can be secured only by having the inlets and outlets both on the same side of the room. When they are on opposite sides as in the case of the Wm. D. Kelly Schools, the pure, warm air rises from the register, passes over the heads of the scholars, down along the opposite wall and into the outlet. The most

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important part of the circuit, viz.: that part which is occupied by the inmates, is omitted altogether. Another faulty method, adopted in the John M. Ogden and Monroe Schools, consists in placing the outlet in the wall at the corner of the room, with the inlet alongside of, and on a level with it. In such cases the cold, foul, air, as it approaches the outlet, is caught in the ascending current of hot air, and thrown up again into the middle of the room. This defect, as it exists in the upper stories of the two schools above named, could be remedied by *raising* the inlets about eighteen or twenty-four inches, allowing the cold current to *pass under* the warmer current. The matter of opening the windows of a school-room as a remedy for defective ventilation, is not only of doubtful, or at least partial efficacy, but it also involves danger to the health and lives of the pupils; to say nothing of the great waste of fuel.

The questions in reference to the languid or fresh appearance and postures of the pupils are difficult to answer; first, because the rules forbid faulty postures, and secondly, because the presence of a casual visitor would serve to dissipate for the time any tendency to exhibit languor or debility. Also as regards *Question No. 11*, I may say that cases of headache and various nervous disorders are frequently met with, which *appear* to be either caused or aggravated by some circumstances connected with school duties and discipline. But whether these troubles arise from the influence of foul air, or hot air, or too long confinement in one position, or improperly fitting school clothing, or excessive application, or undue anxiety to excel, or from some obscure physical weakness, is a question that can rarely be decided with positive certainty. A certain degree of liability to ill health seems to be inseparable from the discipline of school life, however carefully and judiciously such discipline may be improved, and particularly does this appear to be the case in girls, who may be just passing one of the most critical periods of life.

A word as to the various buildings. The John M. Ogden School is the only one in which the cesspool is offensive, and in

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this case the offensiveness results from its location in a narrow space with high walls on either side which protect it from *lateral* currents of air so that the effluvium rises to the school-room windows. Would not self-acting traps in combination with a tall flue, remedy the matter? The cellar of this building is damp, with pools of standing water at times. The faulty grading of the cellar floor renders the drain useless. The light on the east side is seriously obstructed by adjacent buildings.

The Robert T. Conrad and Wm. D. Kelly Schools have no ventilation except by doors and windows, the ventilators being closed, and rendered useless in one case by rust, and in the other by rubbish. One of the third-story rooms of the Kelly School, is kept oppressively hot by the heating of the woodwork surrounding the hot-air flue. There is evidently a serious defect here, to which I would respectfully urge immediate attention.

The Monroe School exhibits a slight defect in its heating arrangements, which has already been referred to. The cellar also contains at times a considerable quantity of water. This cellar I believe is not provided with a drain.

The ventilating apparatus of the Hancock Grammar Schools includes two traps in each room (except one, which has none at all). One of these traps is near the ceiling, and the other near the floor, both opening directly into a warm flue. This arrangement is an excellent one when properly managed, but productive of mischief and discomfort when mismanaged. In cold weather the upper trap should rarely be opened, except to cool off the room. The lower one should be open always. The examination showed several instances in which the lower trap was closed, and the upper one open. The cords by which the traps are controlled are all broken, and many of the traps themselves are unmanageable In the new portion of the building the ventilation is not sufficient for one-third as many pupils as it was designed to accommodate; the vents being too small, too few in number, and placed on the wrong side of the rooms. In Miss Williams' room (third story front), one of the two little outlets is boarded over.

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The Hancock Primary Schools, located at Twelfth Street and Ely's Avenue, above Brown Street, occupy the most uncomfortable and unwholesome school-building in the section; unwholesome first from want of ventilation; secondly, from low ceilings; thirdly from overcrowding. There is no ventilation whatever, except through the doors, windows, and chinks; the average height of the ceilings is eight feet eleven inches, beneath which in three rooms, each 37 by 35 feet, there are crowded 520 children, giving to each child about sixty-six cubic feet of air space. I cannot add anything to the force of this unvarnished statement except by mentioning the additional fact that within three hours after the opening of the session, I found in the lower room .3 per cent. of carbonic acid, in the second story .52 per cent., and in the third story .56 per cent., and this too while in the first story there were five windows open an average of 8 inches each; in the second story, six windows, an average of 12 inches, and in the third story, seven windows, an average of 8 inches. What the condition of these rooms must have been during those bleak days of the past winter, when the windows could not be left open, must be left to the imagination of those who did not experience it, to the remembrance of those whose duties compelled them to endure it, and to the feelings of those to whom it has brought sickness and suffering, and perhaps permanent loss of health. I respectfully submit to your Board, that we cannot too strongly urge the speedy removal of this school to some other and better building.

In conclusion, let me express the hope that my report may be found to aid you, at least in some degree, in your untiring efforts to promote the interests of our schools. I have the honor to subscribe myself

Very respectfully,

Your obedient servant,

PEMBERTON DUDLEY, M. D.

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EIGHTEENTH SECTION.

General Remarks.

As a résumé of the facts embodied in the accompanying reports, I would state, that during my sanitary inspection of the Public Schools of the Eighteenth Section, the truth of the following statements became apparent:

1. That not a single school-house had ventilating arrangements of the slightest use, with the exception of the new Finletter building, and even the apparatus of that very recently constructed edifice was wholly insufficient.

2. That in consequence of such deficient ventilation, particularly in cold weather, not only do the children and teachers become languid and unfit for study, but their lives are greatly jeopardized from the inhalation and re-inhalation of a vitiated atmosphere; my experiments showing, one room observed, to have contained, during the hour of examination, the dangerous percentage of 32 parts of C. O_2 in 10,000, and in several, the amount was found to be over one part in 1000.

3. That the only practicable method of securing a tolerable supply of pure air in the various rooms, was by the uncomfortable and hazardous resource of open doors and windows.

4. That the condition of the privies of the various schools, was, with few exceptions, simply abominable, and notwithstanding the fact that my observations were made in the Richmond school, on one of the coldest days, a fearful odor from the privies pervaded the entire lower story of the buildings.

5. That although the style of desks used in the various schools, may be good enough, yet, owing to the total neglect of proper care in placing children of different sizes at desks of heights suitable to them, they, in a vast majority of cases, assume habitually "faulty postures," both in sitting and standing, and many, likewise, from the same cause, become the victims of defects of the visual organs.

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6. And that, finally, owing to all the before mentioned causes and some others,—absence of ventilation, improper selection of desks, "cramming" of studies, and ill-arranged school sessions, —the rising generation, although, perhaps precociously cultivated intellectually, does not promise to be a race of Spartan physique.

Such then, being the very apparent facts, I would briefly offer a few commonplace

SUGGESTIONS.

1. Every school-building, old or new, whether heated by stoves or hot-air furnaces, should be supplied with a ventilating apparatus, amply sufficient to render its atmosphere during school hours, especially in cold weather, comfortably pure, with all doors and windows closed.

2. The privies should be daily inspected by the janitors, and kept, particularly in warm weather, well deodorized by proper disinfectants, and what is called the "key system," should, as far as is practicable, be introduced into the schools.

3. Desks, of at least three different heights, should be furnished to every large class-room, and special care should be exercised by the teachers in properly locating children of different stature. The custom of changing seats every two weeks, should cease, and the old-time way of having the children occupy their class rank only while at recitation should be revived.

4. Finally, all "cramming" systems should be abolished. The double, daily school session should be replaced by a single session, with half-hour recess, and the children should all be dismissed by 2 P. M., thus enabling them not only to avoid acquiring the peculiarly American habit of rapid dining, but, also, giving them opportunity for that complete relaxation of body and mind, so necessary to the healthful development of all young people.

J. GILBERT YOUNG, M. D.
1000 Shackamaxon Street.

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GENERAL SUMMARY.

Summary and remarks concerning Public Schools of Philadelphia, based upon the answers of physicians to printed questions, upon several general reports, and upon a chemist's report.

Formal reports upon printed blanks are made as to forty-four schools. The examinations were made in the winter and early spring, at different hours and in various weather, by eleven different physicians.

The request in connection with *question 3*, to report upon two or more rooms, has not generally been heeded. In most cases one room only has been examined.

The space allowed to each pupil is too small. The average of rooms reported is 143 cubic feet per pupil. The range is from 272 down to 66, in different schools. Even with efficient ventilation, the space should not fall short of 200 or 300 cubic feet.

The "sensible condition" of the air [*3. b.*] seems to bear little relation to the amount of carbonic acid discovered to be present. The exact percentage of the latter ingredient is stated only by two or three reporters, and in regard to thirty-one rooms in some twenty schools. Whether estimated by weight or by volume is not specified. The ratio of .56, or 56 parts in 10,000, reported in one room, is very extreme. In many rooms however the percentage is not extreme, as in those cases where it ranges from .05 to .10 per cent. The average for thirty-one rooms is .18 per cent. The examination of ten schools by a professional chemist, as given in his special report, exhibits an average of .1315, and a range of from .06 to .21 per cent. In these last, and in nearly all the other cases, it is expressly stated that windows were open. Two analyses of external air showed the presence of .0288 and .03205 per cent. of C. O_2,—the proportion normally varying somewhat with the weather and other conditions.

Light, [*3c. and 3d.*] though usually sufficient, is occasionally inadequate in particular rooms.

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In considering the reported area of inlets and outlets, [*3e.*] it should be remembered that these are often obstructed.

From the reported temperature [*3f.*], we learn that the schools are very generally overheated. This is in spite of the almost invariably open windows,—which are a violation of the specifications made in the question. The temperature in individual cases reached 84°, 82°, 80°, 78°, and a number of times 75° and more. The only marked instances of the opposite fault reported are single temperatures of 58° and 60°.

Answers to *Question 4*, show that a score of the schools examined have no "system of ventilation" whatever. The others have various devices and appliances, variously described.

As to these "systems" being "in order," as asked about in *Question 5*, some fifteen affirmative and nine negative replies are given.

Question 6, is answered by a unanimous and emphatic negative. The general reports of several observers, and the report of the chemist, agree with the tabulated returns, in representing open windows as absolutely necessary to keep the air of our schoolrooms tolerable.

In response to *Question 7*, pupils in nineteen rooms are reported "fresh," in eight "moderately fresh," and in a dozen "languid,"—often with additions, as "restless," "flushed," etc. This, too, in the presence of open windows. The operations of a stranger taking observations would have a tendency to arouse attention and dispel the signs of languor. This influence may have probably affected the replies to this question and the following.

A "bad posture in sitting" is affirmed in sixteen cases, and expressly denied in twenty-six.

An "erect" posture in standing is affirmed in about twenty-two instances. In thirteen the reverse is reported, while in many cases the pupils were not seen on their feet.

In response to *Question 10*, we find the desks designated as "Uhlinger's" in some twenty-five cases, and "Bancroft's" in

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about a dozen. Several reporters describe them simply as "patent," "the usual pattern," etc. Opinions as to suitability are extremely diverse. One point however is often remarked upon, viz.: a lack of relation between the shape and height of the desks and the stature of the pupils.

In a dozen or fifteen instances, the replies to *Question 11* mention "headache" as more or less frequent in the schools. Some seventeen answers are in the negative. "Sleeplessness" and "nervous debility" are each once named. Remote influences affecting health will be further noticed hereafter.

Question 12, as to bad smell, is answered in the negative thirty-eight times, and in the affirmative five times. Privies were usually the source of offence.

The cleanliness of cellars, privies, and drains,—*Question 13*,—is reported "good" in twenty-five instances, "bad" in thirteen and "fair" in six. Wet or damp cellars and foul privies are especially noted in a few cases.

General remarks, and matters not covered by the printed queries, are briefly noted upon many returns. Several gentlemen, too, have prepared reports upon the schools of a section collectively, or upon such imperfections of our schools as have fallen especially under their notice. Some of these are well worth perusal. A very valuable report by the assistant to the professor of chemistry in the Boys' High School, contains analyses of air from ten school-rooms, and from out of doors.

Some of the points covered by these more extended remarks and reports may be here noticed.

The atmosphere of the school-rooms is terribly bad, except when windows are kept open. Practically there is no other means of ventilation. When some pretence to a system exists it is usually wretchedly inadequate or wholly inoperative. Concerning the use of shafts, inlets, outlets, and valves, the teachers are usually ignorant or careless. Openings are choked with rubbish, boarded up, or kept shut by rusted valves and broken cords. In one building, air-shafts were altered into

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closets. In several instances teachers and pupils were made "almost sick" by a temporary closure of windows for experiments.

The rooms examined by Mr. Thomson, the chemist, are said to be very favorable specimens of our schools, being all of recent construction. Even here, windows were constantly open. A very intelligent observer believes that some slight alterations in the ventilating flues of these newer buildings would render them operative and efficient.

This same observer states a fact often overlooked, when he reminds us that a very liberal use of fuel is necessary to any proper ventilation in cold weather.

Some school-rooms, we learn, are heated by close stoves, and in at least one, coal-gas escapes freely from the numerous joints of a long stove-pipe.

Although no question is designed to elicit information as to animal emanations in the close air of the schools, some expressions used by reporters are significant. "Foul," "intolerable," and "mephitic," are words suggestive of something more than carbonic acid gas.

The chemical report already mentioned, and one of the general reports, give clear expression to what we believe to be the true relation between carbonic acid and animal exhalations in their bearings upon the fitness of air to support respiration. As both impurities arise from the presence and the breathing of living beings, both will increase and diminish together, according as the air is repeatedly inspired, or freely changed and renewed. If, then, in a crowded room we find twice as much C. O_2 as in one less populous, we may infer the same proportionate difference in the organic emanations. Thus the first impurity serves, in ordinary circumstances, as a measure for the second.

Moreover it is probably true that the carbonic acid is a less noxious contamination than is the animal matter which it roughly measures. The broken down organic substance, given

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